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BOVINE TUBERCULOSIS

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Tuberculosis is probably the most serious disease of livestock, and is a constant menace. It affects human beings, domestic animals, and wild animals in captivity. The disease is often mild and slow in development and there are many slight and latent cases. A relatively small number of affected animals actually die of the disease, and yet it is one of the three or four most serious diseases of livestock. It is not uncommon to find 70 or 80 per cent of an untested herd to be tuberculous.

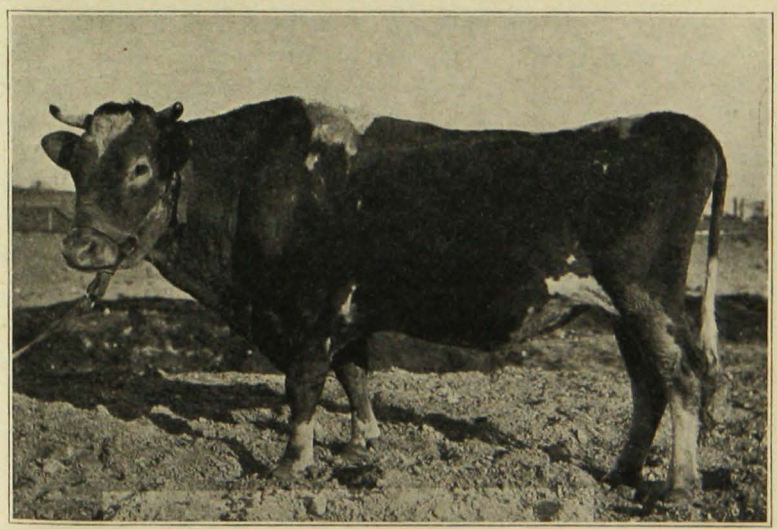

Fig. 1. Tuberculous Bull, Thin and Rough

The fact that human beings may contract tuberculosis from cattle adds greatly to the seriousness of the disease. Young children must have milk, and milk may contain the germs.

RELATION OF TUBERCULOUS COW TO HUMAN HEALTH

Three things have become quite plain in the course of a world-wide study of the relation between human health and bovine tuberculosis: (1) Tuberculosis is a common disease among cattle. (2) Man is susceptible to bovine infection. (3) There are many and constant opportunities for transfer of infection from cattle to human beings, especially children.

It is well known that the lungs of tuberculous cattle may be so affected that diseased areas connect with the bronchial tubes and windpipe; that the udder may have diseased areas communicating with the milk ducts; and that there may be tuberculous ulcers on the lining of the intestines. The animals may swallow material coughed up from the lungs and in this way easily infect the bowel contents. It is possible for milk to be contaminated either from within the udder or from dried manure on the udder, flank, or tail. There are, then, at least three ways in which the tuberculous cow may give off tuberculosis germs: in milk, in manure, and in the spray thrown off in coughing.

CAUSE OF TUBERCULOSIS

No fact in medicine appears to be better demonstrated than that the mycobacterium (bacillus) of tuberculosis is the cause of this disease, aided by factors which may depress vitality and resistance, and contribute to the tissue changes. This germ is an extremely minute plant, rod shaped. It is said that about six red blood corpuscles could be placed in a row across the end of a fine human hair, and that about six of these minute plants which cause tuberculosis could be placed end to end across each of those corpuscles. This little plant multiplies by division, that is, each one divides itself into two.

DISSEMINATION

The diseased animal is the dangerous thing, not so much the stable or method of feeding or watering, but the animal. The germs may be given off from the mouth or nose, in the milk, in the manure, or even from the skin, if the skin is infected.

So far as is known there is little difference in the susceptibility of the different breeds of cattle. Under usual conditions there is more among purebred cattle and in city dairies, but some grade farm herds are very badly affected. When purebred cattle are more generally affected, it is not because of their breeding, but

because of greater exposure to infection, closer confinement, and management for appearance or production rather than for vigor and hardiness. The more closely cattle are confined, and the more unsanitary the surroundings, other things being equal, the greater the number affected.

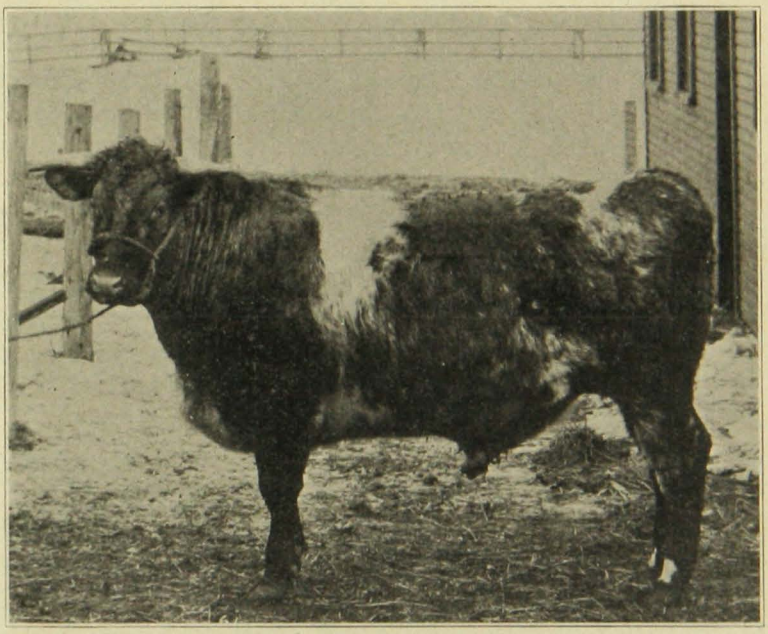

Fig. 2. Lord Roberts, Famous Show Steer
In prime condition but tuberculous.

The germs of tuberculosis may be taken in by the healthy animal through the lungs, with food or water by way of the stomach and intestines; or through a cut or scratch.

Hogs usually receive their infection from cattle, either from milk or manure or a diseased carcass.

The disease is most frequently introduced into a healthy herd by a diseased animal, frequently by one purchased for the purpose of improving the herd. Occasionally show stock contract the infection at fairs or in cars previously used by diseased animals. Cattle may even become infected in pasture.

STRUCTURES AFFECTED

Tuberculosis of domestic animals may involve almost any part of the body except the hair, horns, and hoofs. Actual infection of muscle tissue is apparently rare, but lymph glands between muscles may be diseased. The disease may affect parts that would

not ordinarily be examined and there may be no visible lesion even at a point where there is tuberculosis. This explains why cattle may fail to show plain tuberculosis on examination of the carcass, after reacting to the test.

SYMPTOMS

There are no positive symptoms by which tuberculosis can be detected. Ordinary physical examination of the living animal is usually unsatisfactory, but is an important aid when made in connection with a tuberculin test. An animal may appear to be doing exceedingly well, to be in perfect health, and yet be very extensively diseased. Dairy cows have made milk records while tuberculous and winning steers at fat-stock shows have been tanked for grease because the carcass was badly diseased. See Figure 2.

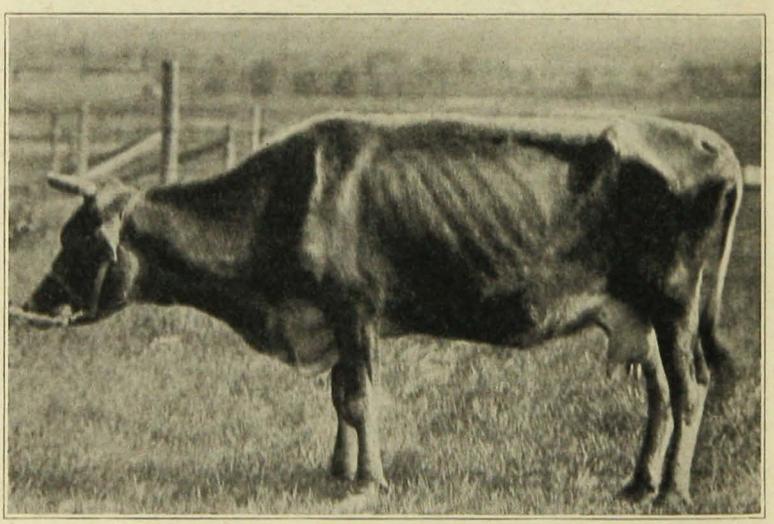

Fig. 3. Non-Tuberculous Cow

She had a tumor on the intestine near the stomach and was very unthrifty in spite of good care.

Some tuberculous cattle are unthrifty. They may show a slow loss of flesh and a mild chronic cough that is usually subdued and infrequent, or they may show difficult breathing and enlarged glands of the throat. Cattle occasionally have tuberculosis of the digestive organs and are subject to repeated attacks of indigestion, perhaps bloat, or they may show a chronic and incurable diarrhea. A few show lumps in the udder. Hard masses which develop slowly in a cow's udder without much inflammation are always suspicious, but not all enlarged quarters are tuberculous, by any

means. In rare cases the skin may show nodules which are tuberculous. As a rule, examination of the living animal for tuberculosis does not give satisfactory information.

The carcass may show no lesions, or very slight ones, or the chest and abdominal cavity may be extensively diseased. The word tubercle suggests a lump. Tubercles that are characteristic of tuberculosis may vary in size from a kernel of wheat to a considerable mass, but they all have a similar characteristic structure and consistence.

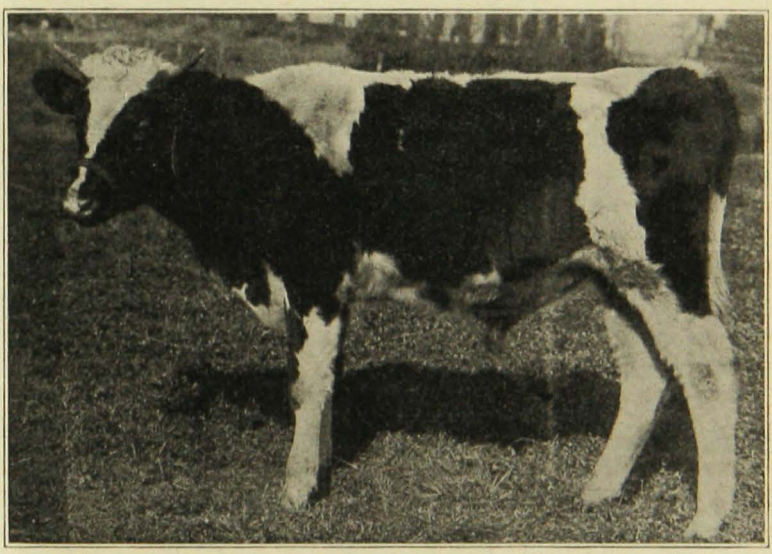

Fig. 4. Tuberculous Young Steer
In good condition and making good growth.

Three types of lesions are produced by the virus of tuberculosis. One type is the cheesy and gritty lymph gland, often enlarged, for example, the glands between the lungs. A second type is an abscess in the substance of any of the soft organs. In another type we find growths attached to the lining of the chest or abdominal cavity.

MEDICAL TREATMENT

There is no medical treatment that can be recommended for tuberculous cattle. When an animal is definitely known to be tuberculous it should be killed.

Bang method.—The Bang method of treatment is not satisfactory in this country as a rule, and is not to be recommended except under unusual conditions. In this method tuberculous cattle are used for breeding purposes and their offspring are raised on milk

from healthy cows or on pasteurized or sterilized milk of the dams, and are kept away from the diseased cattle. This procedure usually means the management of two distinct herds, preferably on two farms, and complete isolation in every important respect for the diseased cows.

TUBERCULIN TEST

It is quite obvious that with physical examinations of the living animal so uncertain, something else is quite necessary, so three tuberculin tests have been developed. None of them is infallible. All are reasonably accurate and of great practical aid in control work when backed by experience, skill, and good judgment. A tuberculin test does no harm to healthy cattle and rarely to tuberculous cattle.

Tuberculin is used in fluid or tablet form. It is produced by growing the germs of tuberculosis in a sort of broth. This culture is later boiled in order to kill the bacteria, and is then filtered to remove the dead bacteria. It therefore contains none of the bacilli, only their products. The tuberculin test is based on the well known fact that infected cattle are usually very sensitive to these products and that other cattle are not sensitive. The three tests now in use are the thermal, intradermal, and sensitized or double ophthalmic. Various combinations of these are often made.

Thermal.—In making the temperature test, three preliminary temperatures are taken to establish the normal range of temperature for each animal, which may be anywhere from about 99 to 103 degrees, F. Tuberculin is then injected under the skin or into the muscle, and temperatures are taken every two hours, beginning with the eighth and continuing to the eighteenth hour, or longer if the animals show a rising temperature but have not yet given a reaction. It is often advisable to continue with animals that show high temperatures, until there is a decline to approximately normal. In this test, tuberculous cattle show a fever; healthy cattle show little or no disturbance of temperature.

The standards upon which animals are passed or condemned are more or less arbitrary and artificial, but some standard appears necessary. Our present standards are based upon a vast amount of practical work.

A rise of about 2.5 degrees or more above the highest preliminary temperature usually indicates tuberculosis, providing the highest preliminary temperature is itself a reasonably high normal.

Intradermal.—The intradermal test is given by the injection of a very small quantity of tuberculin into the skin at some suitable

place, usually into a fold of skin at the side of the root of the tail. A swelling at the place of injection lasting about 72 hours or more, usually means tuberculosis. In some cases the reaction is clearly indicated in less than 72 hours. Other cases do not show a plain reaction until 96 or 120 hours. This test requires special skill and care, a considerable amount of experience, and a good sense of touch. Under these conditions it is very useful.

Ophthalmic.—The ophthalmic test is best given in two treatments. The tuberculin for this test is now ordinarily used in tablet form. The first treatment is given by inserting a tablet under the upper eyelid for the purpose of sensitizing and making reaction after the second treatment more positive if the cattle are tuberculous. The second treatment is given from 48 to 72 hours later. It is better to give the preliminary treatment if only 12 or 15 hours interval is available.

A reaction in the ophthalmic test shows congestion, profuse flow of tears, sometimes swelling in the lower eyelid, and especially pus at the corner of the eye. Healthy cattle show little or no effect if the treatment is given carefully and the eye is not injured when the tablet is inserted. In this test, it is advisable to examine the eyes before treatment to make certain that there is no eye trouble which might lead to error.

These tests are all reasonably accurate, practical, and decidedly useful. Either test, when made with care, skill, experience, and judgment, is as accurate as could be reasonably expected. It is important to realize that a tuberculin test is usually essential in diagnosis—at least the most important single item but not the only item to be considered. There are many other things to be considered, as herd and individual history, reputation of the owner and also of the seller in case of recent purchase; surroundings before and during test, feeding, watering, and exercise or the lack of it. Routine diagnosis on apparent showing of the test leads to errors both ways, condemning sound animals and passing unsound ones. Such errors are avoidable. Some errors are unavoidable so far as the veterinarian is concerned; but the owner is entitled to careful consideration of each animal.

ADVANTAGES AND DISADVANTAGES OF THE TESTS

Thermal (temperature).—This test has several advantages. It is the oldest, with most data available, and is well known. No unusual veterinary skill is needed. Its evidence of reaction can be submitted easily and plainly to an owner or to a distant official. It is probably the most reliable of the three tests in first herd

tests, and in the hands of the average operator.

The **disadvantages** are that it is relatively slow, involves more work and more expense; is inaccurate under unfavorable conditions; is not usable under certain conditions, for example, when preliminary temperatures are high; may lead to error when fever from some other cause occurs on the second day; is undesirable and inaccurate with cattle less than six months old; and has a marked tendency to develop immunity against tuberculin for future tests.

Intradermal (in the skin).—Its **advantages** are: It is rapid and economical; it causes the least disturbance of the animals and the stable routine; it may be used at any season and for practically any age. The evidence of reaction is not easily lost, and it is probably less objectionable than the temperature test so far as conferring immunity against tuberculin in future tests.

Its **disadvantages** are: It requires more skill and experience on the part of the operator than either of the others; slight but diagnostic reactions are easily overlooked; there is more risk and danger for the operator; and evidence of reaction may be there but not appreciable to the owner.

Ophthalmic (eye).—The **advantages** are: It is comparatively rapid and economical, comparatively easy to give, and the results are easily interpreted. It does not appear to be hindered to any serious extent by previous tests. In other words, it is a good repeater. Certain types of tuberculous cattle appear especially likely to react to the ophthalmic test, altho there are not sufficient reliable data available upon which to base a positive statement. It fits in well with either the intradermal or the thermal test.

The **disadvantages** are: The evidence of reaction may be very brief and be overlooked and it is easily lost or removed by a dishonest owner; other eye disturbances which happen to occur after the treatment may be mistaken for a reaction and healthy cattle be condemned.

Relative accuracy

One of the most common questions which owners ask concerns the relative accuracy of the several tests. Accurate information is meager, altho statistics of considerable weight have been published. Definite statements on this question are worthless unless influencing conditions are all specified. Conflicting results between different tests may be due as much to varying potencies of the tuberculins used as to individual peculiarities of the animals tested. In any combination test where many animals react, and for example

the intradermal, checks well with probabilities and autopsies and the temperature test fails to give reactions or the reverse, a possible explanation, in view of actual experience that we have had, is that one tuberculin was more potent for its use than the other.[1]

Serious conflict between test and autopsy is due to poor tuberculin, poor testing, or incompetent autopsy, or there are obscure infections that can not be found under existing conditions and with available means. The last is quite common, especially in areas or herds where testing and re-testing have been done.

HERD MANAGEMENT WITH A VIEW TO PREVENTION

The owner must always consider such general features as light, ventilation, and stable cleanliness, and realize that as a rule it is impractical to keep tuberculous and healthy cattle on the same farmstead.

Perhaps the problem of herd management with a view to prevention can better be presented by a study of common items of mismanagement, for example, starting with a clean herd and adding new animals without making a tuberculin test before purchasing and perhaps a home retest from sixty to ninety days later; taking a chance without test in case of a desired animal; failing to buy from a reliable breeder; getting a herd clean by means of the tuberculin test and then failing to keep it clean by proper disinfection, sanitation, and retests; trying to maintain a healthy herd in crowded, dark, and unventilated stables; buying an untested nurse cow for use in the herd; defeating the accuracy and purpose of a test by too much testing; the use of group feed and water troughs and mangers.

It should be clearly understood that while there is less danger and less rapid spread of tuberculosis in a thoroly sanitary stable, such a stable will not eradicate tuberculosis. It is easily possible to have a very badly diseased herd in a very good stable.

In case of suspected or questionable animals, milk should be pasteurized or boiled before being used for any purpose.

PUBLIC CONTROL WORK

It is important to avoid unnecessary use of the thermal test because most tuberculous cattle easily lose their sensitiveness to tuberculin. The thermal or temperature test should be limited to cattle at least a year old, and the ophthalmic and intradermal should be used for young cattle. For public control work, we consider

[1] See California Agr. Exp. Sta. Rept. 1921-22, p. 168, and Exp. Sta. Record (U. S. Dept. of Agr.) Vol. 48, No. 6, p. 583.

the policy of very large doses of tuberculin in the thermal test and unnecessarily repeated testing of any cattle as unsound policy.

If an owner wishes to have his herd tested, his general procedure would be as follows: First consult the local veterinarian, or if unable to do this, consult the State Livestock Sanitary Board, Old Capitol, St. Paul. The veterinarian who makes the test must make an official report to the Livestock Sanitary Board. Reacting and suspicious cattle are condemned and appraised on the owner's premises, then shipped for slaughter to some point where there is federal inspection. The owner receives whatever is realized from the carcass and from the state two-thirds of the difference between carcass returns and appraisal, and if the herd is accredited or is becoming accredited, an additional one-third of this difference

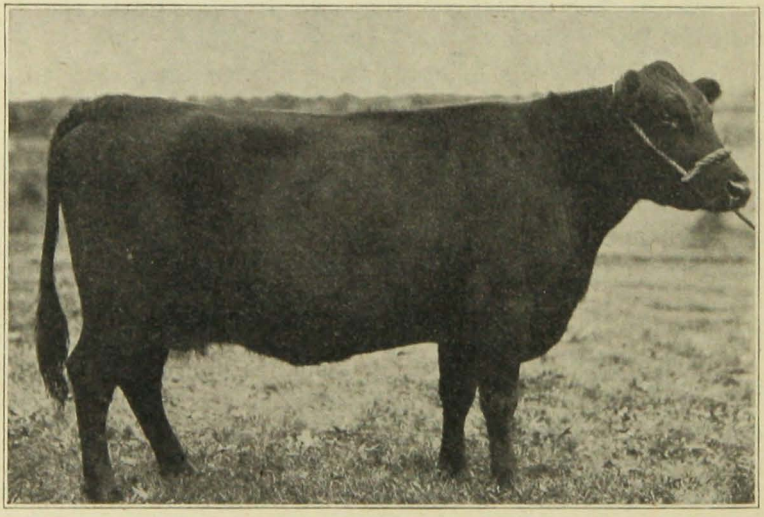

Fig. 5. Tuberculous Purebred Cow in Fine Condition

This cow was a spreader. The nasal discharge and the manure both carried live tuberculosis germs. The paunch and the floor of the abdominal cavity were badly diseased.

from the federal Bureau of Animal Industry. After the diseased animals have been removed, the stable should be thoroly cleaned and then thoroly disinfected. This is to be done after each test which discloses reactors. Reacting cattle must have a condemn tag placed in the left ear, and a letter T three inches high branded on the left cheek. For future identification grade non-reacting cattle are given a different style of tag in the right ear.

The control of tuberculosis must be recognized as a long-time proposition and any work which proposes rapid and complete eradication is of doubtful soundness. We must also recognize

purebred cattle as of first importance so far as control work is concerned, because the general movement of purebred cattle is from farm to farm. A single tuberculous purebred animal may often spread tuberculosis in several different herds. Therefore with a given available fund, the authority in charge of public work should first of all provide as nearly as possible for complete testing and retesting of breeding herds.

Accredited herd.—The accredited herd movement is one of the most significant and promising features of modern tuberculosis control work. An accredited herd is one that is recognized by the state and federal governments as free from tuberculosis, and this recognition is based upon the following general requirements. Grade and scrub herds (ten or more), as well as purebred herds and mixed herds are eligible.

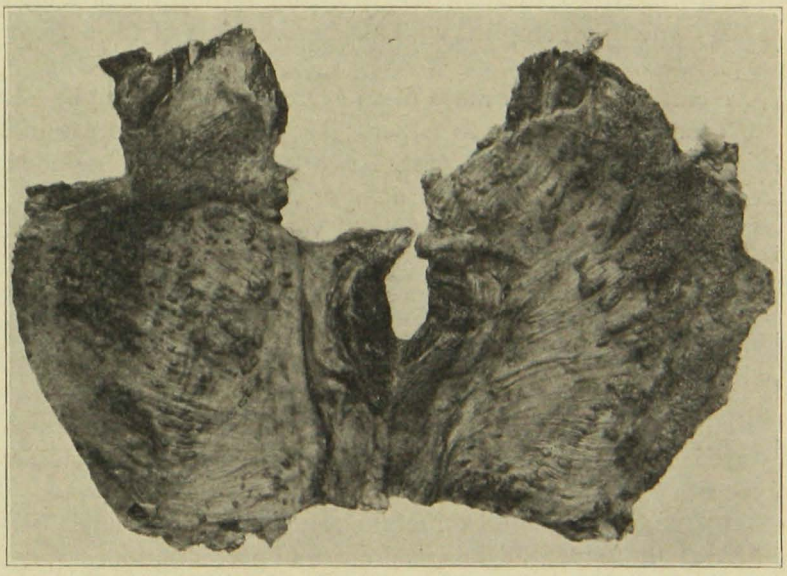

Fig. 6. Abdominal Side of Diaphragm, Badly Diseased
This was taken from the cow shown in Figure 5.

Before full accreditation, a herd must pass two negative annual or three negative semi-annual tests. The initial testing in accredited herd work may be by either the subcutaneous or the intradermal method, but the ophthalmic method shall be used only in combination with one of the others. If the initial test was by the intradermal method and some animals reacted, a retest must be made in from 90 to 180 days by combined thermal and ophthalmic tests. If the initial test was by the thermal method, the retest must be by combined intradermal and ophthalmic tests

"For a herd which in any previous test shows evidence of infection." Before being accredited, the final test should be by a combination of recognized tuberculin tests applied at the discretion of the federal and state authorities.

"The entire herd, or any cattle in the herd, shall be tuberculin tested or retested at such time as is considered necessary by the federal and state authorities, usually once a year.

"No cattle shall be presented for the tuberculin test which have been injected with tuberculin within sixty days immediately preceding, or which have at any time reacted to a tuberculin test."

"An accredited herd in which not more than one reactor is found at a subsequent tuberculin test, may be re-instated to the list when the entire herd passes a successful test without reactors; said test to be applied not less than four months from the date when the reactor is removed from the herd and farm, provided further that the owner has complied with all requirements of the accredited herd plan.

"No cattle other than those of an accredited herd shall be added to an accredited herd or to a herd that is in the process of accreditation, until they have passed two tuberculin tests applied at intervals of not less than sixty days or more than ninety days by a regularly employed state or federal veterinarian, or by a veterinarian specially authorized by the state or bureau to conduct such tests. The cattle may, after passing the first test, be placed on the farm or premises containing an accredited herd or one in the process of accreditation, but must not be allowed to associate with said herd until after passing the second test.

"Before a herd can be accredited the stables and premises shall be placed in a sanitary condition. When reactors are disclosed as the result of any test, they must be immediately removed from the farm and the stables thoroly cleaned and disinfected before the herd shall be identified as in process of accreditation.

"All milk and other dairy products fed to the calves shall be that produced by an accredited herd, or if from outside or unknown sources, it shall be pasteurized by heating to not less than 150 degrees F. for not less than 20 minutes."

The advantage of accreditation for the breeder, especially, is valuable advertising and increased salability of his cattle. It aids public control of tuberculosis and gives a good reputation to the cattle of any state which can show a large number of accredited purebred herds. It also enables the owner of an accredited herd to ship to other states or to sell and ship directly to purchasers in his own state with a minimum of delay and inconvenience. The

necessary certificate of test for an animal from an accredited herd is obtained from the State Livestock Sanitary Board.

Law and regulations.—(Minnesota.)—The law, and State Livestock Sanitary Board regulations relating to tuberculosis may be summarized as follows: There is no general compulsory testing in this state; but there is a requirement in several city milk ordinances that milk sold within the city limits must be pasteurized or come from cows tuberculin tested and passed. The owner is not compelled to have his cows tested, but he cannot sell milk within those particular cities unless he tests them or pasteurizes the milk.

In area work, after a majority of cattle owners have signed the petition and county commissioners have made necessary arrangements with the Livestock Sanitary Board, all cattle in the county are tested or quarantined.

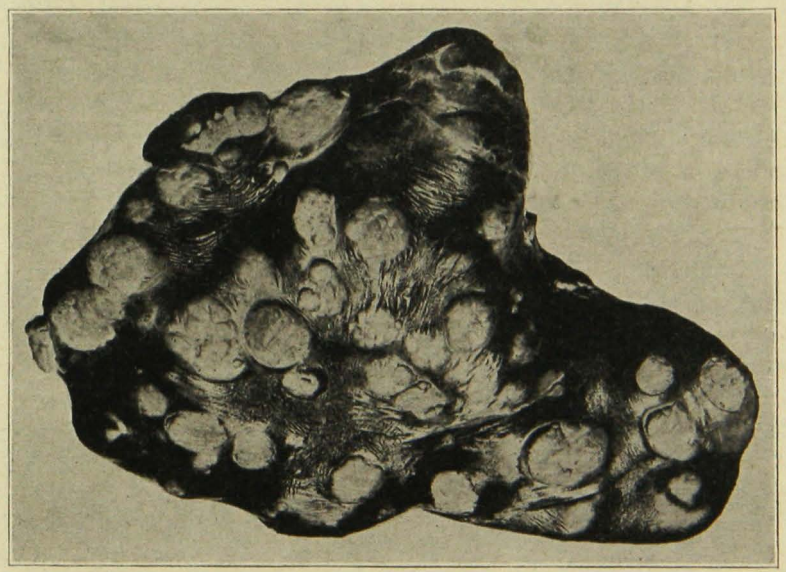

Fig. 7. Tuberculous Liver
The large tuberculous areas are cheezy and gritty on cutting.

Purebred cattle sold for other purposes than immediate slaughter, and one year old or over, must be tested for the purchaser before sale unless they have been tested within one year under the direction of the State Livestock Sanitary Board. The purchaser is entitled to a copy of the test record.

Cattle coming into the state must be accompanied by satisfactory certificates of health and satisfactory tuberculin test made

within thirty days prior to shipment. This does not apply to cattle coming into terminal public stockyards like South St. Paul or to cattle for immediate slaughter.

Purebred cattle coming into the state must be subjected to quarantine and retest at destination not earlier than sixty or later than ninety days after the preceding test. This does not apply to cattle from acceptably accredited tuberculosis free herds.

The State Agricultural Society now requires that all cattle for exhibition at the State Fair must have passed a satisfactory tuberculin test.

Our State Holstein Breeders' Association requires members to have their herds tested.

These items all show clearly the public sentiment in Minnesota as well as the condition of our purebred herds.

Owner's legal rights.—If cattle are tested in a legal and proper way by a private veterinarian recognized by the State Livestock Sanitary Board, by a veterinarian in the employ of the board, or by the federal Bureau of Animal Industry, and are pronounced tuberculous, the next thing is appraisal, except in case of cattle belonging to public institutions. The present appraisal limits in Minnesota are $60 for grade cattle and $150 for purebred and registered cattle. The tuberculous cattle are then tagged and branded as previously mentioned, and shipped to some point where there is federal inspection, as South Saint Paul, and there killed under inspection. The cattle belong to the owner all the time, the state is merely helping him to dispose of his tuberculous cattle. The state even pays freight and yardage for him. Indemnity is allowed only when reacting cattle are disposed of as directed by the State Livestock Sanitary Board; when one year old or older; when they have been kept in the state one year or more; when killed within 150 days after condemnation; when requirements concerning disposition of products from tuberculous cattle have been complied with; and when infected stables have been properly cleaned and disinfected.

Area work.—There is a general interest in what is known as area control work, this policy being followed in many states, and on a considerable scale by the government and the states in cooperation. The usual unit is the county, and the general plan is to clean up one county at a time. The requirements upon which an area can be fully accredited are essentially the same as for the individual herd. The testing must include all cattle within the given area, and before this area can be officially recognized as tuberculosis free (accredited) or as a modified accredited area, the

public authorities in charge of the work must have assurance of sanitary restrictions that will avoid re-infection.

For the county that desires to have this project undertaken, the Minnesota law and regulations provide first for a petition signed by the majority of cattle owners, and addressed to the county commissioners. This petition is to the effect that the county be included in the area work project. The commissioners are then authorized to apply to the sanitary board and before work is undertaken they must provide for an appropriation of 25 cents per head for each test of all cattle within the county. There are ordinarily at least two tests, and in some counties and herds sev-

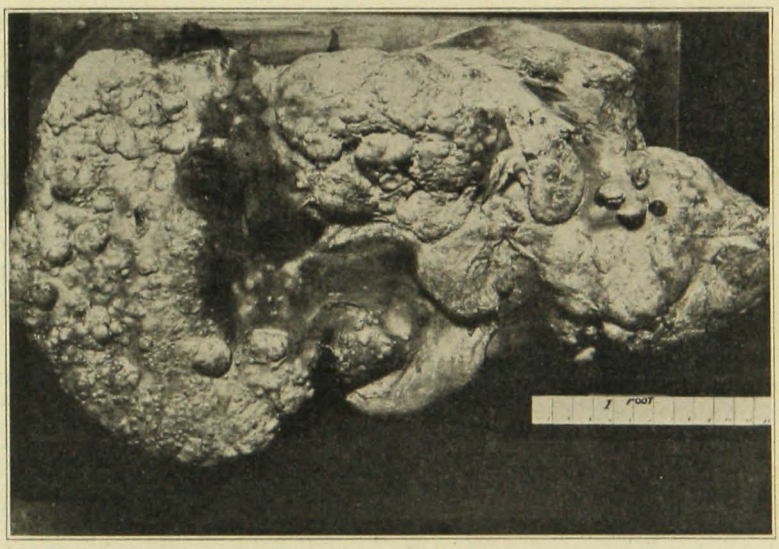

Fig. 8. Tuberculous Liver

Note tuberculous masses on the surface and in the substance. The organ was about six times the normal size and weighed 75 pounds. (From animal shown in Fig. 1.)

eral additional tests, before the total reactions in the county are reduced to 0.5 per cent, when the county becomes recognized as a modified accredited area. Individual herds in which reactors are disclosed are quarantined, and retested. (See "Accredited Herds.") Importation is allowed only from accredited herds or on recent tuberculin test, except in case of cattle for slaughter and steers for feeding. These steers are to be placed in quarantine and kept away from all other cattle on the farm. There are special rules for areas which show 1 per cent of reactions and for those showing between 0.5 and 1 per cent.

In view of the importance of the problem and the slow progress in the past, any new proposition that has a reasonable chance of more rapid success should have a fair trial.

The area plan should be given a fair trial on a large scale and have public support, but further experience may show the need of several important modifications. We need a carefully checked study, under widely varied conditions, of the obvious difficulties and the feasibility of overcoming them, the cost through a term of years, and the probable rate of actual progress.

In tuberculosis control work, durability of public confidence and support will depend ultimately on actual cost and actual results, not on apparent results or on propaganda.

The work already done is arousing a great deal of interest and resulting in widespread education on the subject of tuberculosis control. It has done away with a large number of spreaders; but tuberculosis control must be regarded as a long-time problem and not something that can be accomplished in one grand sweep. It must be kept in mind that it is easily possible that the preliminary work, that is, the first test, in a large number of counties under area work, may go faster than will allow any reasonable possibility of careful follow-up, faster even than is wise. It is probable that many owners will become indifferent after the first test, and a first test is only a beginning.

For the area plan to be effective, proper quarantine regulations and proper care with reference to importation into this area, prompt and regular future tests and retests, must all be carefully safeguarded.

It is obvious that before tuberculosis can be even approximately eradicated we must have a more rapid method, uniform and dependable tuberculin, more accurate diagnosis, less expensive procedure in general, and greatly increased funds. It may be necessary gradually to reduce and finally do away with reimbursement. This will probably be difficult.

A very gradual reduction is the best that can be expected with present knowledge and facilities. Complete eradication in the sense that pleuro-pneumonia and foot and mouth disease have been eradicated, can not be accomplished for many years